Fire Management notes

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Wildland Fire Aviation: Past, Present, and Future

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On the Cover:

Counterclockwise from upper right to lower right: A Bell Model 47B landing on a helispot in 1947 on the Bryant Fire, Angeles National Forest, CA (see related article by Mike Dudley and Greg Greenhoe). Photo: USDA Forest Service, Angeles National Forest, Arcadia, CA, 1947. A B–17 dropping retardant in August 1968 on the Fourth of July Mountain Fire, Wenatchee National Forest, WA. These World War II bombers are no longer used as airtankers. Photo: USDA Forest Service, 1968. A C–130 dropping retardant on a 1994 fire in southern California. C–130's are part of the new generation of large airtankers used on wildland fires. Photo: Cecil Stinson, Jr., USDA Forest Service, Shasta–Trinity National Forest, Redding, CA, 1994. A type 1 helicopter (an S–64F from the Erickson Air-Crane Co.) using its snorkel to fill its tank—part of the new generation of helicopters used to support wildland firefighters. Photo: Courtesy of Erickson Air-Crane Co., L.L.C., Central Point, OR, ©1998.

The FIRE 21 symbol (shown below and on the cover) stands for the safe and effective use of wildland fire, now and in the 21st century. Its shape represents the fire triangle (oxygen, heat, and fuel). The three outer red triangles represent the basic functions of wildland fire organizations (planning, operations, and aviation management) and the three critical aspects of wildland fire management (prevention, suppression, and prescription). The black interior represents land affected by fire; the emerging green points symbolize the growth, restoration, and sustainability associated with fire-adapted ecosystems. The flame represents fire itself as an ever-present force in nature. For more information on FIRE 21 and the science, research, and innovative thinking behind it, contact Mike Apicello, National Interagency Fire Center, 208-387-5460.

FIRE 21

Firefighter and public safety is our first priority.

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Short Features

National-Level Interagency Aviation Coordination

Elmer Hurd, Pat Kelly, and Skip Scott

Effective Federal fire management demands well-coordinated aviation support from U.S. Department of the Interior (USDI) agencies and the USDA Forest Service. Before 1993, disagreements arose between the USDI agencies and the Forest Service over several contentious issues that were ultimately resolved in dependently by each agency. Policy differences persisted because there was no satisfactory mechanism for resolving them.

> The National Fire Aviation Coordination Group has proven an effective forum for providing solutions without confrontation or program failure.

In December 1993, the National Fire Aviation Coordination Group (NFACG) was established to "coordinate aviation support for Federal fire management programs and activities." Coordination is vital when addressing crucial interagency issues related to aviation. The NFACG consists of the director, USDI Office of Aircraft Services; the assistant director, Fire and Aviation Management, USDA Forest Service; and the aviation program manager, USDI Bureau of Land Management.

The NFACG holds meetings as needed, usually quarterly, to address issues such as standardization of policies and procedures, aircraft and pilot specifications and approval standards, and aviation business management. Between meetings, the group holds conference calls to address issues that require rapid resolution. The NFACG is proactive, forming working groups to identify future coordination opportunities and to act on them. For example, the Smokejumper Aircraft and Equipment Evaluation Board will coordinate how the agencies address issues related to aircraft and equipment for smokejumping.

Even though contentious issues have arisen since the group was formed, the NFACG has proven an effective forum for providing solutions without confrontation or program failure. For example, at the peak of the 1994 fire season, the various agencies and/or regions imposed separate flight and duty limitations on pilots to guard against pilot fatigue, a serious concern because that fire season was exceptionally long and intense. Because agencies acted independently of each other in setting

A meeting of the National Fire Aviation Coordination Group, established in 1993 to address crucial interagency issues related to aviation. Members are (from left) Skip Scott, aviation program manager, USDI Bureau of Land Management; Pat Kelly, assistant director of Fire and Aviation Management, USDA Forest Service; and Elmer Hurd, director of the USDI Office of Aircraft Services.

Elmer Hurd is the director of the USDI Office of Aircraft Services, National Interagency Fire Center, Boise, ID; Pat Kelly is the assistant director of Fire and Aviation Management, USDA Forest Service, Washington Office, Washington, DC; and Skip Scott is the aviation program manager, USDI Bureau of Land Management, National Interagency Fire Center, Boise, ID.

limitations, pilots who were compelled to take days off in one geographic area were permitted to fly in another. The NFACG identified this problem and resolved it in cooperation with the national fire coordination community by providing for incremental decreases in allowable duty hours and days during periods of prolonged intense flight activity.

In October 1997, the Federal Fire Aviation and Fire Leadership Council asked the NFACG to broaden its scope to include both fire and nonfire aviation issues. The group is currently rewriting its charter to provide for overall coordination on aviation issues between the USDI agencies and the Forest Service. Through its expanding role, the NFACG promotes interagency aviation coordination at the national level, facilitating Federal fire management for the future. ■

The Aviation Management Triangle

The aviation management triangle stands for sound, professional aviation management. The rotary and fixed-wing aircraft at the core of the triangle symbolize the aircraft we use in our profession. The triangular shape represents our commitment as aviation managers to the three fundamental principles of aircraft use: safety, cost-effectiveness, and selection of the right tool for the job. Aviation management is a service function; as aviation managers, we use aircraft to provide safe, cost-effective, and appropriate aviation services.

- The foundation of aviation management is ***safety***. If the mission cannot be safely accomplished, say NO! Use sound risk management to ensure that levels of risk are acceptable.
- Strive for ***cost-effective*** aircraft use. Question requests that are not cost-effective; explain why they are not, and recommend a better alternative.
- Use the ***right*** aircraft for the job. Question requests for inappropriate aircraft; explain why they are inappropriate, and offer a better solution. Do what's right!

Fifty Years of Helicopter Firefighting

Michael Dudley and Gregory S. Greenhoe

It is 1300 hours on August 5, 1947, and you are fire boss on a large wildfire on the Angeles National Forest in southern California. You face:

- A rapid rate of fire spread;
- Steep and rugged topography, with temperatures exceeding 107 °F (42 °C);
- Dependence on call-when-needed hand crews to staff firelines;
- High resource values at stake;
- The potential for line personnel fatigue due to steep terrain and a 4,000-foot (1,200-m) elevation difference from the point of origin to the head of the fire;
- Terrain unsuitable for the use of heavy equipment; and
- The inability to support line personnel with food and water.

What tool could you possibly use for transporting firefighters and supporting them on the line? Today, the answer is simple: aerial resources. In 1947, however, the answer was far from simple. That year, helicopters were used for the first time to support fire suppression, changing forever how we fight wildland fire.

The Bryant Fire

Late on that fateful August afternoon, the fire boss (now known as the incident commander) ordered two helicopters to assist in suppressing the Bryant Fire on the Angeles National Forest (Greenhoe 1997). On the following morning, two Bell Model 47B helicopters owned by the Armstrong-Flint Helicopter Company arrived on the fire from their nearby home base at Whiteman–Park Airport in Van Nuys, CA. With a portable pump drafting water from nearby Big Tujunga Creek to wet down the landing zone and with the hood of a Jeep as the base of operations, the first base heliport ever was in full swing.

Within 2 hours of their arrival, pilots Knute W. Flint and Fred Bowen had flown four missions. The opportunities for using the helicopters were so apparent that Forest Supervisor William Mendenhall reported to the regional forester that "we soon had a serious congestion of missions, and we had to limit the use of the helicopters to the most urgent traffic" (Mendenhall 1947). Fifty years later, things haven't changed much.

Over the next few days, the helicopters were used for a wide variety of missions, including transporting firefighters to the line and delivering their food, drinking water, and other supplies. These machines also proved invaluable as tools for fireline reconnaissance and mapping.

Early Experimentation

Earlier experiments with helicopters had helped set the stage. In 1945, the Forest Service and the U.S. Army ran tests using the Sikorsky R–5A and R–5B. Ira Finch, a Forest Service engineer, and Fred Mileav, an Army Air Corps veteran, conducted these tests under western weather conditions. In 1946, the Alaska Fire Service flew a Sikorsky R–5 on a fire near Fairbanks, AK; later that year, the Forest Service used another

A Bell 47B helicopter approaching Stone Canyon helispot on the 1947 Bryant Fire, Angeles National Forest, CA. Photo: USDA Forest Service, Angeles National Forest, Arcadia, CA, 1947.

Mike Dudley is an aviation management specialist for the USDA Forest Service, Washington Office, Washington, DC; and Greg Greenhoe is the forest fire management officer for the USDA Forest Service, Angeles National Forest, Arcadia, CA.

Ground crew loading fresh water for delivery to the firelines on the 1947 Bryant Fire, Angeles National Forest, CA. Photo: Courtesy of Lynn R. Biddison, Albuquerque, NM, ©1947.

Sikorsky R–5 on the Red Rock Fire on the Angeles National Forest near Castiac, CA. All these early missions were test flights for aerial reconnaissance, scouting, and mapping.

Not until the Bryant Fire in 1947 did full operational use of a helicopter occur, making the value of the helicopter immediately apparent. Until that moment, there was no assurance of success, because previous tests on the Sikorsky and Bell aircraft had occurred under far different conditions. For example, operating elevations and temperatures during the tests had been much lower than those on the Bryant Fire.

Beginnings of Current Helibase Operations

When the helicopters arrived on the fire at dawn on August 6, it soon became evident that an air operations section was needed and that it should report directly to the chief of staff (the line boss, now known as the operations section chief—the person charged with executing the fire boss's strategy).

Lyle F. Reimann of the San Dimas Experimental Forest Staff quickly formed a helibase organization. Reimann used a Jeep between the landing zone and fire camp, and had two crewpersons to load and unload cargo, help service the aircraft, and brief personnel on using their safety belts. He also had a portable pump in the river 100 yards (90 m) away to wet down the landing zone and two carbon dioxide fire extinguishers in case of emergency. Such were the humble beginnings of our current aviation organization.

In a report to the regional forester in September 1947, Forest Supervisor Mendenhall emphasized the value of this new resource, stressing the need for establishing:

- The position of air operations officer with specific duties on a fire,
- Safety standards for all users,
- A training program for the air operations officer and ground crew,
- Standards for helispots,
- Air-to-ground communications, and
- A water-dropping capability.

In addition, he recommended designating an air operations officer for the southern California zone to facilitate helicopter use plans, training, and safety programs; and establishing a liaison with other agencies that were working with helicopters to capitalize on their findings and avoid duplicating their efforts (Mendenhall 1947).

Fifty years later, the Angeles National Forest celebrated the birth of wildland fire aviation on the anniversary of the Bryant Fire. On August 5, 1997, a ceremony was held in the Rose Bowl in Pasadena, CA, just a few air miles from the site of the Bryant Fire, to honor the early pioneers of rotor aviation. Included was a demonstration of modern helicopter technology. In addition, a small monument commemorating the first operational use of helicopters on a wildland fire was permanently installed at the Angeles National Forest, Big Tujunga Fire Station, very near the original operating area.

Acknowledgment

The authors would like to thank Ralph Johnson of Boise, ID, a retired helicopter specialist for the Forest Service, for contributing some of the material in this article. He was the speaker at the August 1997 ceremony in Pasadena, CA, commemorating the 1947 Bryant Fire and the first operational use of helicopters in wildland firefighting.

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The Aerial Firefighting Industry Association: History and Accomplishments

William R. Broadwell

Privately owned aircraft play a key role in today's wildland firefighting. Since 1988, the Aerial Firefighting Industry Association (AFIA) has supported commercial companies that operate firefighting aircraft under contract with Federal and State wildland fire management agencies. Through the AFIA, commercial airtanker operators maintain a vital two-way communication with agencies responsible for wildland fire management, enhancing our Nation's wildland fire suppression capabilities.

> Close collaboration between the AFIA and government agencies enhances our Nation's ability to fight wildfires using safe, cost-effective commercial airtankers.

AFIA History

The activities of the AFIA are financed primarily by companies that operate large multiengine airtankers. These airtankers are the primary asset in the USDA Forest Service's national airtanker program; they are generally not used for purposes unrelated to government wildland firefighting. Consequently, the viability of the large airtanker industry depends on 1) continued Federal contracting with commercial airtanker companies to meet national aerial firefighting needs and 2) contracts in sufficient numbers to sustain a viable industry.

In 1988, faced with these realities, the large airtanker industry formed the AFIA to advance the common interests of its member companies. The AFIA supports its members by informing the Government wildland firefighting agencies and the public at large about the safety of commercial airtankers and the economic benefits of using them.

The AFIA's original members were all large airtanker operators. Today, its members are more diverse; they come from distinct aerial firefighting communities that use three different types of aircraft: large multiengine airtankers, helitankers, and single-engine airtankers.

Currently, AFIA members include 13 commercial airtanker com-panies that operate more than 75 multiengine airtankers, single-engine airtankers, and helitankers; and 3 sustaining member com-panies that support the associa-tion's goals. This membership diversity provides the AFIA with a broad perspective for representing the industry. Detailed information on AFIA members can be found on the AFIA Website at <**http://www.afia.com**>.

AFIA Functions

The AFIA advances the common interests of the commercial aerial firefighting industry by enhancing the long-term stability of the industry and by improving aerial firefighting effectiveness, safety, maintenance standards, and aircraft availability. Toward this goal, the AFIA has established effective two-way communication links between airtanker operators and the U.S. Department of Agriculture, U.S. Department of the Interior, and State firefighting agencies. These links have enhanced the decisionmaking process by enabling timely industry input into major government decisions regarding policy, contracting, and airtanker performance specifications, and by improving the airtanker operators' ability to meet current and future aerial firefighting needs through better planning information.

Another equally important function of the AFIA is to ensure that Federal and State agencies, legislators, and the general public are aware of the objectives of the airtanker industry and of its contributions to the well-being of our Nation's citizens and economy. Although AFIA employs the services of professional public relations firms to help shape its program, efforts are most effective when coordinated with public relations teams from all parts of the wildland firefighting community.

Bill Broadwell is the Executive Director of the Aerial Firefighting Industry Association, Springfield, VA.

AFIA Accomplishments

In several areas over the past few years, the interface between the AFIA and Government agencies has proven beneficial to all sides and played a key role in shaping the future of the industry.

Interagency Airtanker Board (IAB). As a result of an AFIA suggestion, there is now a 30-day comment period for industry input to Government proposals to change performance specifications for the tanking and gate system (the computer-controlled system in the belly of an airtanker that allows the pilot to regulate the amount of retardant dropped). In 1997, the industry was invited to submit comments on a proposed revision to the IAB manual. At a subsequent IAB meeting, AFIA members played an active role in discussing the merits of each proposed change. The current working relationship will ensure improved tank and gate system performance while controlling costs.

National Airtanker Study. Conducted from 1995 to 1996, the *National Airtanker Study* was important in shaping the future of the industry and providing guidance for airtanker modernization. Industry had already begun airtanker modernization in the late 1980's, but further direction was needed on the numbers, types, and capabilities required by Government agencies for the national airtanker program fleet. Early in the study's preliminary data-gathering phase, the AFIA membership was invited to comment on aspects of the airtanker business that the study team considered important. The resulting study now allows the operators to modernize their fleets with the confidence that they are meeting documented Government requirements.

Wildfire Suppression Aircraft Transfer Act of 1996 (S. 2078). This Act allows qualified bidders to purchase excess military aircraft for conversion to airtankers. Crucial to both the AFIA and the Forest Service, S. 2078 contains enabling legislation for *National Airtanker Study* recommendations regarding airtanker modernization. Industry support for this bill was needed for its passage. During the early formulation stages of the bill, the Forest Service solicited industry comments and incorporated AFIA input into comments submitted through agency channels. During the congressional staffing process, the AFIA expressed strong support for the bill through its congressional contacts. As a result of S. 2078, the industry has a reliable means for continuing to modernize its airtanker fleet to meet future Federal and State wildland firefighting requirements. Although procuring aircraft through the commercial market remains an option, in the long term S. 2078 will reduce procurement costs for airtanker operators and lower contract costs for Government wildland firefighting agencies.

AFIA's Future Role

With the planned size and composition of the future national large airtanker program now defined by the *National Airtanker Study,* the AFIA has turned to examining how the study's recommendations will be implemented. The study recommends a future fleet of 41 large, commercially operated turbine-powered airtankers with various tank capacities. Yet to be defined are several related issues important to the industry's ability to procure aircraft through S. 2078, including:

P3–A Orion airtanker dropping retardant on a wildfire. Airtankers play a vital and highly visible role in wildfire suppression support. Photo: USDA Forest Service, Washington, DC.

- The implementing regulations under S. 2078, currently being drafted by the U.S. Department of Defense;
- The Forest Service's preferred transition schedule for airtanker modernization; and
- The contracting procedures that will support the large initial investment in turbine aircraft.

These issues will best be resolved through AFIA's continued close cooperation with the Forest Service and other Government agencies. Through the lines of communication that have proven so effective in the past, we can continue to work together to enhance our Nation's ability to fight wildfires using safe, cost-effective commercial airtankers.

For more information on the AFIA, contact Bill Broadwell, P.O. Box 523068, Springfield, VA 22152, tel./fax 703-644-6454, e-mail: broadwel@erols.com. ■

Helicopter Association International: A Profile

Frank L. Jensen, Jr.

Millions of Americans have seen helicopters at work fighting wildland fires, either on television or in person. Helicopters are highly effective in dropping huge quantities of water precisely where needed to help firefighters on the ground suppress fire. That's why Government agencies responsible for managing wildlands have used helicopters in firefighting for more than 50 years (see related article in this issue by Mike Dudley and Greg Greenhoe). Government agencies use helicopters for many other purposes as well, such as ferrying personnel and conducting wildlife surveys.

Helicopter Professionals Working Together

Helicopter professionals, almost without exception, are rugged individualists—people with a strong and independent nature and the ability to survive against challenging odds. It is probably only natural for these traits to flourish in the helicopter industry, where we work with very capable but complex machines, often in an environment that is less than ideal.

But even rugged individualists realize that they must work together at certain times to accomplish goals that are too difficult to reach individually. That's why, in 1948, helicopter professionals founded the predecessor organization to Helicopter Association International (HAI). Worldwide, HAI is now the largest, most visible, and most influential organization dedicated exclusively to civil helicopters. HAI is also the only nonprofit organization that is equally active in aviation and small business matters.

Frank Jensen is the president emeritus of Helicopter Association International, Alexandria, VA.

HAI's mission is to advance the civil helicopter industry by promoting the highest levels of safety and efficiency.

HAI's Mission and Makeup

HAI's mission is to advance the helicopter industry. We promote the highest levels of safety and efficiency by encouraging communication and cooperation among members; enhancing professional skills and business acumen; collecting, compiling, and analyzing pertinent, useful data, and sharing the resulting information; establishing a favorable legislative and regulatory environment; and encouraging and recognizing outstanding achievement, thereby increasing public recognition of the important contributions of the civil helicopter to society.

At this writing, HAI has 2,653 members, including:

- 623 regular members—commercial, corporate, or government organizations that operate helicopters. These members operate about 4,000 helicopters, safely flying more than 2 million hours annually.
- 683 associate members, including manufacturers of airframes, engines, avionics, components, and accessories; plus repair stations, insurance companies, financial firms, brokers, consultants, and all others who in any way support the civil helicopter industry.
- 66 affiliate members—nonprofit entities that have interests and goals in common with HAI.
- 1,281 individual members.

HAI is led by a board of directors elected by and from among the members. The board has nine voting members, including five commercial operators, three corporate operators, and one Government operator. In addition, the board has several ex officio members, including representatives from engine and airframe manufacturers and from insurance, safety, and public relations organizations, plus three special advisors. HAI's president and corporate secretary are also ex officio members of the board.

HAI's Activities

Many of HAI's accomplishments result from the excellent work by HAI's 22 committees. All committee participants are volunteers who work without compensation to advance the civil helicopter industry. Described below are just a few

of our many activities on behalf of the civil helicopter industry.

HELI-EXPO. HAI's most visible activity, HELI-EXPO, is an annual trade show that routinely attracts more than 13,000 professional registrants. HELI-EXPO typically has 450 exhibiting companies and 1,300 exhibit booths, with 65 to 70 helicopters on display inside the exhibit hall. HELI-EXPO is listed among the top 200 trade shows in the United States.

ROTOR. *ROTOR* is HAI's official trade publication, a quarterly full-color magazine with 48 or more pages. Professionally edited and produced, *ROTOR* publishes feature articles and items of interest to those in the civil helicopter industry. Now in its 10th year, *ROTOR* has a print run of 20,000 copies.

Visitors learning and enjoying themselves at HAI's HELI-EXPO '98. Commemorating HAI's 50th anniversary, the convention was held in Anaheim, CA, on February 15–17, 1998. Almost 13,000 visitors attended; 475 companies exhibited and 69 helicopters were on display. Photo: Courtesy of Bob Rabito, Lagniappe Studio, New Orleans, LA, ©1998.

Website. The HAI Website (at <**http://www.rotor.com**>) is a tremendous source of civil helicopter-related information compiled at HAI and brought to the industry and general public through the Internet. Hosting some 81 other homepages, HAI's Website is well visited: as of this writing, there have been more than 530,000 hits! Some of the more popular areas on our Website include:

- "Today's News," updated every business morning;
- "Helicopter Parts Search," an online parts locator that matches potential buyers of spare parts with suppliers;
- "Aircraft for Sale/Lease," which allows sellers to showcase their aircraft;
- "Hot Spots," with links to other helicopter companies and aviation sites;
- "Heliport Search," for locating heliports in the United States;
- "Maintenance Malfunction Information Reporting" (MMIR), an automated data base listing more than 50,000 experience reports on helicopter components and parts. The MMIR system is capable of detecting incipient failures and supplying information for extending life limits and/or overhaul times.

Industry Support. Timely action on behalf of the industry is a major priority for HAI. Our activities in support of the civil helicopter industry include testimony before congressional committees and subcommittees several times a year. In addition, HAI maintains close contact with top administration officials, including members of the Cabinet and sub-Cabinet, and with senior officials at a number of Federal agencies on a wide range of matters involving both aviation and business. HAI also writes letters to and makes personal appearances before authorities worldwide to present the views of the civil helicopter industry.

Member Services. In addition to promoting HELI-EXPO, publishing *ROTOR*, maintaining our Website, and developing the MMIR system, HAI's most prominent member services include:

- Publishing *Operations Update*, a monthly newsletter that tracks regulatory changes; Federal, regional, and user meetings; airspace actions; public hearings; and proposed Federal rule changes that affect helicopter operations.

- Producing *Maintenance Update*, a quarterly publication that provides a forum for mechanics and technicians to exchange information on regulatory issues, airworthiness directives, aircraft alerts, and items of special interest.
- Developing educational programs. HAI offers 18 or more courses on a break-even basis to almost 500 helicopter professionals, mostly during the week prior to our annual HELI-EXPO. Course offerings include:
  - A flight instructor refresher course that meets the Federal Aviation Administration's requirements for biannual recertification;
  - A helicopter operators management course that covers the business aspects of operating helicopters; and
  - A safety managers course.
- Publishing *Helicopter Annual*. Since its inception in 1983, this publication has grown into a full-color, comprehensive reference that includes industry statistics and trends; descriptions and capabilities of HAI's members; and information on helicopters, components, and services.

Service Awards. HAI's Salute to Excellence Awards recognize and encourage professionalism in the helicopter industry. The first such award was the Pilot of the Year Award, established in 1960. The next award, the Robert E. Trimble Memorial Award for distinguished flying in mountains, was first presented in 1962. Over the years, HAI's Salute to Excellence Awards have increased in number and prestige. HAI's leadership takes very seriously the establishment and administration of these awards. We have sought to provide suitable awards for excellence in most helicopter activities, mindful of the need not to authorize too many awards so as to preserve their value and significance. The Salute to Excellence Awards are presented each year at a special awards banquet, with more than 1,000 persons in attendance—a very prestigious and dignified ceremony.

Collaboration With Federal Agencies

HAI works very closely with Federal agencies such as the USDA Forest Service, based on our mutual interest in using helicopters to suppress wildfires and to support forest management in other ways.

In 1997, for example, the Forest Service and HAI cochaired a meeting in Boise, ID, on helicopter use in wildland firefighting. More than 40 representatives attended from Federal land management agencies and the helicopter industry. At the meeting, a panel from the Forest Service, the USDI Office of Aircraft Services and Bureau of Land Management, and HAI's Executive Committee and Government Contracting Committee responded to questions prepared in advance, followed by open discussion. The questions, responses, and discussion were all very constructive, generating a great deal of interest and enthusiasm. The clear consensus was that the meeting succeeded in facilitating an open exchange on a topic of great importance to both the Government and the private sector, and that future such meetings should be considered.

Fifty Years of Service

HAI's 50 years of accomplishments were made possible only by the generous and sustained dedication of many volunteers. Every member of the board, every committee participant, and many others have significantly contributed to HAI's progress, often at personal expense. This is particularly true for volunteers from small companies, whose absence from their workplace often affects the bottom line.

For further information on HAI, contact us by fax at 703-683-4745, or by e-mail on our Website at <**http://www.rotor.com**>. For a summary report of the 1997 meeting in Boise, ID, on helicopter use in wildland firefighting, send a self-addressed, stamped (55 cents postage) #10 envelope to "Summary Report," c/o HAI, 1635 Prince Street, Alexandria, VA 22314-2818. ■

One of Our Aircraft Is Down! Handling an Aircraft Crash on a Fire

Gary Morgan

For a fire incident commander, an aircraft crash on an incident enormously complicates an already complex situation. The first question is always whether anyone was hurt, and the next is what action to take. By carefully preparing for the eventuality of an aircraft crash on a wildfire, fire managers can reduce confusion and pave the way for a timely, effective response.

The first and foremost priority in an aircraft accident on a wildfire is the health and safety of the persons involved.

Preparing for an Accident

Right after initial notification of a downed aircraft, confusion is the greatest complicating factor. The best way to reduce confusion is to plan for a postmishap response in a good, clear section of the Aviation Plan as part of the overall Incident Action Plan (IAP). The intent should be to reduce confusion and manage the situation while continuing the firefighting operation—in other words, to deal with the mishap as an "incident within an incident."

Like the IAP as a whole, the Aviation Plan is designed to save time and reduce confusion under circumstances where delays can be costly. In developing the Aviation Plan, aviation managers should list aviation assets to be activated if the situation warrants. The safety portion of the Aviation Plan should cover:

- Person(s) in charge,
- Primary aircraft and crews,
- The alert process,
- Communications, and
- Preliminary actions to take following an aircraft mishap.

Gary Morgan is the aviation safety manager for the USDA Forest Service, Eastern Region, Milwaukee, WI.

Responding to an Accident

After hearing that an aircraft is down, aviation managers should immediately activate portions of the Aviation Plan that apply to an aircraft mishap.

Initial Notification. Aviation managers should immediately contact the medical unit leader, the operations section chief, and the incident commander. The incident commander will in turn contact the agency administrator, and law enforcement, safety, and fire information officers will also be notified. After initial actions are underway and the incident commander is alerted, aviation managers should make the calls recommended in their local *Crash Rescue Guide*.

Health and Safety. The first and foremost priority is the health and safety of the persons involved in the accident. Procedures should be in place for medical response and evacuation of the injured. Any fatalities will complicate handling and protocol. States and counties have different procedures for dealing with these matters, and these must be considered.

Collateral Damage and New Fires. After the people involved in a crash have been cared for, the next issues to address are collateral damage and any fires started by the crash. If there are fires, a team should be named for initial attack. Team members must be informed before arriving on the scene of any hazards associated with the type of aircraft that crashed. Hazardous materials could pose a problem, particularly if there is a fuel spill, and the proper personnel should be notified for response. If the site is threatened by fire, action should be taken to protect the area, if feasible, to limit damage and protect the site for the accident investigation.

Site Security. After the initial response crew is in place, efforts must be made to preserve the site and get preliminary information needed for the ensuing investigation. Law enforcement officers can be very helpful in this regard and might be needed throughout the investigation, which could last several days. Site security is a concern—curious onlookers should be kept from disturbing the site and thereby making the investigation more difficult.

Accident Investigation. During preparations for an incident, a person should be named to handle the preliminary investigation. If an incident occurs, this person will start setting up a formal accident investigation and will take initial steps to help the investigation team when it arrives.

Evidence that might lead to discovery of the cause of the accident can be lost in the first 24 hours after a mishap. The preliminary investigation manager can provide valuable assistance by preserving such evidence. A preliminary investigation kit and checklist are helpful (see sidebar); kits should be kept at aviation facilities where staff know how to use them effectively.

To aid the investigation team, additional materials should be gathered with the help of law enforcement, claims, and safety officers. These materials include:

- Video footage or a set of photographs of the site from all directions.
- Written or tape-recorded statements from witnesses. It is important to interview witnesses as soon as possible and one at a time, because if witnesses speak to others or get much time to think about what they saw, their memories tend to change under outside influences.
- A good log of observations and actions taken at the site. Such a log is helpful in documenting response actions.
- Records such as aircraft maintenance documents and logbooks, pilot logbooks, flight manifests, weight and balance sheets, dispatching documents, radio tapes, and any other documented information surrounding the flight. Such records are an essential source of information for investigators and should be collected at the first opportunity.

Site of a downed helicopter on the 1996 Tower Complex Fire on the Umatilla National Forest, OR. Accident investigators search for clues while keeping a watchful eye on nearby fire activity, which is not yet threatening. Although the crash site was initially outside the fire team's management boundary, fire conditions changed on the following day, and investigators donned Nomex shirts, posted watches, and prepared an evacuation plan under the direction of the incident commander, whose careful preparations on this fire benefited the investigation team. Photo: Gary Morgan, USDA Forest Service, Eastern Region, Milwaukee, WI, 1996.

Preliminary Accident Investigation Checklist

When an aircraft goes down on a fire, the person named to initiate the investigation should prepare a preliminary checklist to aid the investigation team when it arrives. A good list includes:

- Date and time of the mishap,
- Name and telephone number of reporting individual,
- What was observed and where,
- Names of the crew and passengers,
- Extent of injuries,
- Aircraft "N" number and operator,
- Measures taken to secure the site,
- Names and telephone numbers of witnesses, and
- Weather conditions at time of mishap.

Be Prepared!

An aviation mishap can distract and confuse an unprepared fire manager. The best way to avoid confusion is to have a clear, comprehensive plan in place before the mishap occurs. Even though every precaution must be taken to prevent them, accidents should be planned for in wildland firefighting. If an accident does occur, good preparation will lead to swift, effective response, improving performance by rescue teams and increasing the likelihood that the investigation team will find the cause. By addressing contingencies early and identifying steps for immediate response, fire managers will reduce distraction from the principal task at hand—controlling the wildland fire. ■

Lessons Learned in Aviation Safety

Dennis Hulbert

In the 1960's, the USDA Forest Service's aircraft accident rate was higher than today (fig. 1)—high enough to cause grave concern. The fatality rate for Forest Service aviation was almost three times that of general aviation throughout the United States. From 1968 through 1973, 19 people died and 47 were injured in Forest Service helicopter accidents alone. Human error caused 60 percent of Forest Service aviation accidents and mechanical failure another 30 percent, with 10 percent attributable to environmental causes.

> The single most prominent factor associated with aircraft accidents and incidents today is deviation from policy and standard operating procedures.

Promoting Aviation Safety

To promote aviation safety, the Forest Service set out to change the aviation program. Safety measures included:

- Implementing a national aircraft accident and incident reporting system now known as SAFECOM.
- Rewriting Forest Service Manual 5700 to create an extensive aviation oversight and management organization that is still in place today.
- Writing and implementing an aviation handbook system that still guides and directs most of our aviation activities.

As figure 1 shows, this series of safety measures succeeded in drastically reducing the rate of Forest Service aviation accidents. Over the years, the Forest Service has continued to struggle for aviation safety, drawing lessons from each new accident and devising new policy to prevent its recurrence. Based on accident investigations and management reviews of aviation mishaps, the agency now has an aviation safety training program and a comprehensive manual and handbook system for aviation safety.

Despite these measures, however, accident rates within Forest Service aviation have stubbornly resisted further reduction in recent years (fig. 1). Within all agencies nationwide, airtanker mishaps alone continue to cost an average of two lives each year—a very high figure, especially considering the relatively small size of the fire aviation community. State and Federal agencies contract only about 75 airtankers nationwide each year. For the crew members who operate this small fleet, an average rate of two deaths per year from airtanker accidents is a serious concern.

Policy Deviation—A Dangerous Tendency

Today, the single most prominent factor associated with aircraft accidents and incidents is deviation

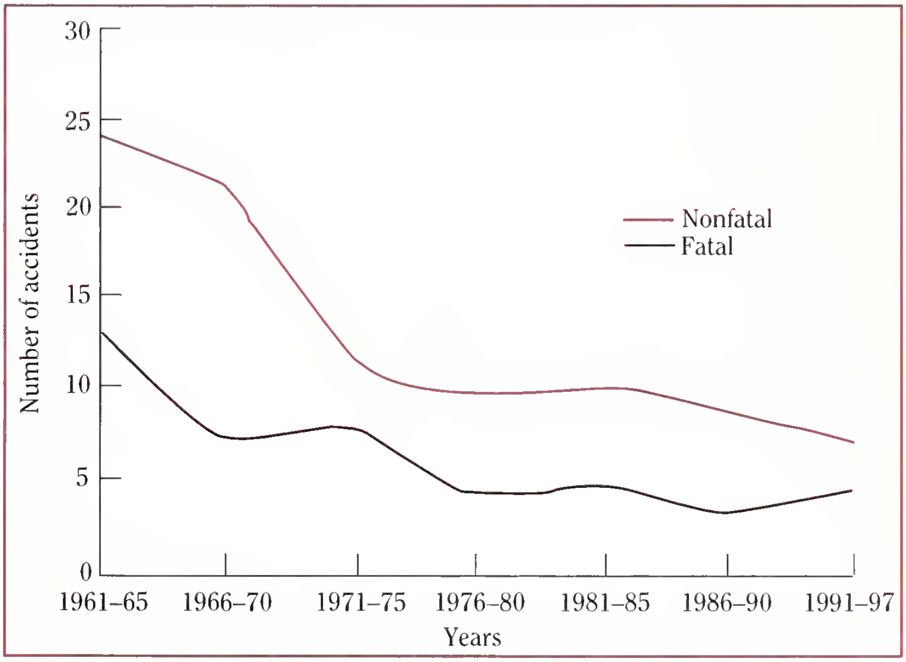

***Figure 1**—Accident rates for Forest Service aircraft from 1961 to 1997.*

Dennis Hulbert is the aviation safety and training manager for the USDA Forest Service, Pacific Southwest Region, Mather, CA.

from policy and standard operating procedures by employees, managers, and pilots. If this is the case, are we really learning from past accidents? Why do we keep making the same mistakes?

As an aviation safety manager in the Forest Service's Pacific Southwest Region with 25 years of experience in agency aviation, I've come to realize that the struggle for aviation safety is never ending and that we must constantly maintain and update our safety program. We must *market* safety, together with the polices and procedures needed to ensure it. Our safety message must appeal to users in order to be remembered and followed.

People deviate from policy either because they are unaware of it or because they choose not to follow it. I don't believe we need more policy; instead, as managers we need to educate our aviation users on what the policy is and what the consequences will be if they choose not to follow it.

Ironically, more often than not, those who fail to follow policy pay no penalty. I myself have deviated from policy more often than I care to admit, without adverse consequences. Those who truly suffered the consequences are the ones who had accidents. Their sacrifices must not be in vain—we must learn from them!

Tools for Marketing Aviation Safety

"Lessons Learned" Video. In 1997, the Forest Service's aviation safety management produced the 32-minute video "Lessons Learned" (available through the Forest Service's regional aviation safety managers). Going back 20 years, we selected four accidents and one incident with potential, and we reenacted each case in the video. For each, we retell the surrounding events, give causal and contributing factors, and summarize lessons learned. Each case highlights a different type of error:

1. Failing to file a flight plan during a routine passenger flight. The plane stalled under mountain flight conditions, resulting in one death, one injury, and a demolished aircraft (fig. 2).
2. Flying into icing conditions during a routine passenger flight. The wings iced up and the plane stalled, resulting in four deaths and a demolished aircraft (fig. 3).
3. Failing to follow proper aircraft performance planning, such as calculating load. The helicopter crashed while making a routine initial-attack landing on an offsite helispot, resulting in two deaths, one injury, and a demolished aircraft.
4. Failing to follow agency-mandated carding procedure to verify aircraft certification. A helicopter making a wildlife census count experienced a severe mechanical failure that almost cost those aboard their lives, resulting in disciplinary action for the Forest Service employee aboard.
5. Flying in turbulent weather while mopping up a lightning fire. A downdraft caused a helicopter needlessly operating under dangerous conditions to crash while attempting to make a water drop, resulting in one injury and a demolished aircraft.

Hindsight is always best, but perhaps we should be using aircraft based less on convenience or availability and more on fire behavior. The last case reenacted in "Lessons Learned," the helicopter accident on the lightning fire, immediately raises the question: Why was this helicopter mopping up this nonthreatening fire in the first place?

***Figure 2**—Crash site of a Forest Service aircraft in the Intermountain Region in 1980. Described in the "Lessons Learned" video, this crash was due to pilot error. Photograph: USDA Forest Service, Intermountain Region, Ogden, UT, 1980.*

Figure 3*—Crash site of a contract aircraft in the Pacific Northwest Region in 1992. Described in the "Lessons Learned" video, this crash was due to wing icing. Photograph: Ralph Poole, USDA Forest Service, Pacific Northwest Region, Portland, OR, 1992.*

We fail to weigh the risk and cost of using aircraft resources against the probability of success when we use helicopters to mop up fires where fire behavior indicates little threat; when we use airtankers to drop retardant at midslope where fire behavior shows that the fire will burn to the top of the ridge no matter what we do; or when we use retardant aircraft without the benefit of having firefighters on the ground. Such risky, ineffective practices amount to fighting fire based on convenience rather than fire behavior.

Fire managers note that they are under public pressure to use idle aircraft during firefighting operations, even when using them is risky and ineffective under prevailing wind or other conditions. If fire managers are indeed under such pressures, then we need to reeducate our public and change the culture within our agency. If we are the experts in fire management—as I believe we are—then let's call it like it is: if retardant aircraft or helicopters are ineffective under certain circumstances and if sound decisionmaking based on fire behavior does not demand their use, then let's not use them. In addition to reducing exposure and risk, we might save money.

The fourth case reenacted in the "Lessons Learned" video, a helicopter incident with potential, occurred in February 1997, when a Forest Service employee who was conducting an elk census violated agency safety regulations by boarding a Hiller 12 helicopter that had not been inspected and certified by the Forest Service. During the flight, a broken linkage rod disabled the steering mechanism, and the pilot could no longer guide the aircraft down. With the helicopter ascending at full pitch into the clouds, a fatal outcome seemed inevitable. In a desperate effort to restore control to the pilot, the Forest Service employee stepped out onto the helicopter skids and spent 30 minutes in freezing winds trying to repair the damaged rod. With his hands frozen and his gloves and a contact lens blown away, he finally managed to slip a makeshift pin into the linkage, enabling the pilot to regain control.

This dramatic incident highlights the need to follow procedures: had the Forest Service employee done so, he would not have risked his life by boarding what turned out to be an unsafe aircraft. This incident reflects the fact that Forest Service aviation safety policies are not always well understood or closely followed outside of the agency's fire organization, even though many Forest Service employees are required to use aircraft for activities unrelated to fire.

Chief of Party Program. Forest aviation officers are responsible for effectively marketing fire aviation safety practices throughout the agency. They must reach out not just to the fire community, but to all aviation users. A good tool for this purpose, in addition to "Lessons Learned," is the Chief of Party Program developed in 1997. The program includes:

- A video,
- An independent-study workbook,
- Safety wallet cards featuring "The Five Steps of a Safe Flight" and "Twelve Standard Aviation Questions That Shout Watch Out," and
- The "Interagency Aviation User Pocket Guide" (NFES 1373).

Available through Forest Service regional aviation safety managers, these tools can be used at all organizational levels, at little cost to the field and manager.

"Bull Fire Entrapment" Video. Another available video that crosses aviation and fire management lines and demonstrates the

need to follow policy and procedures is "Bull Fire Entrapment," created in 1996. This 30-minute film taken from actual infrared footage reenacts a helicopter crew breaking all of the "10 Standard Firefighting Orders" and 14 of the "18 Situations That Shout Watch Out" while deploying on a fire. The last few minutes are quite intense—the crew barely escapes with their lives by jumping into the helicopter as the spot they are on is overrun with flames (fig. 4). Along with "Lessons Learned," this video is a must for all fire personnel and fire suppression pilots.

Let's Learn From the Past and Be Safe!

All Forest Service employees share responsibility for aviation safety and are expected to take timely action to mitigate unsafe conditions. To meet this responsibility, employees need a basic understanding of aviation policy and procedures, and the ability to recognize unsafe conditions. As with any other safety program, we must learn from past failures to ensure future safety.

I strongly encourage all fire and aviation managers to *market* a safe aviation program. Use the tools and videos referred to in this article as you develop your own aviation safety program to meet your specific needs. Don't let up on training requirements, and please learn the lessons from our past failures! Remember: Those who fail to learn from the past are condemned to repeat it.

For more information about aviation safety videos, Chief of Party Program training materials, and other aviation safety programs, please contact a forest aviation officer or regional aviation safety manager. ■

Figure 4*—Illustration of an actual incident when a helicopter crew narrowly escaped before a fire burned over the helispot. As described in the "Bull Fire Entrapment" video, crew members had broken numerous safety rules. Illustration: Candy Butrick, Loomis, CA, 1996.*

Aviation Safety Materials Available

The aviation safety videos and publications listed below are available through the National Wildfire Coordinating Group's National Fire Equipment System (NFES). Prices are subject to change; those given below for some items are to help estimate the cost of an order.

To order, mail or fax a written request to National Interagency Fire Center (NIFC), Attn: Great Basin Cache Supply Office, 3833 S. Development Avenue, Boise, ID 83705, fax 208-387-5573/5548. Show item(s) requested and the corresponding NFES number(s); shipping address; and billing address, including requisition or purchase order number (or, alternately, Visa/Mastercard information). ***Please do not phone in your order.*** Allow 4 weeks for delivery.

Aviation Safety Videos

NFES #2152—"Basic Air Operations," 1991, 37 minutes.

NFES #2392—"Helicopter Capabilities and Limitations," 1993, 12 minutes, $3.00.

NFES #2090—"Helosafe," 1988, 13 minutes, $3.00.

NFES #2391—"One Yankee Gulf," 1993, 21 minutes, $4.00.

NFES #2002—"The Professional Helicopter Pilot Supporting Wildland Fire Suppression," vol. 1, 1993, 16 minutes, $3.00.

NFES #2487—"The Professional Helicopter Pilot Supporting Wildland Fire Suppression," vol. 2, 1995, 19 minutes, $3.00.

[NFES number pending]—"Aircraft Chief of Party," 1996, 25 minutes.

[NFES number pending]—"Bull Fire Entrapment," 1996, 30 minutes.

[NFES number pending]—"Lessons Learned," part 1, 1998, 32 minutes.

[NFES number pending]—"Winds, Wires, and Weights," 1988, 15 minutes.

Aviation Safety Publications

NFES 2393—"Aircraft Identification Guide," 1994, 43 pages, $1.00.

NFES 2097—"Basic Aviation Safety Student Guide," 1991, 15 pages, $0.50.

NFES 1399—"Five Steps to a Safe Flight," card.

NFES 2512—"Interagency Aviation Technical Assistance Directory," revised annually, 33 pages, $0.50.

NFES 1373—"Interagency Aviation User Pocket Guide," 1998, 23 pages.

[NFES number pending]—"Aircraft Chief of Party Workbook" (self-study guide for use with corresponding video), 1998, 23 pages.

[NFES number pending]—"Five Steps to Risk Management," card.

[NFES number pending]—"Twelve Standard Aviation Questions That Shout Watch Out," card.

Annual Accidents/ Incidents Video

In addition to the aviation safety materials available through NIFC, the 15-minute video "Department of the Interior and Forest Service Aircraft Accidents and Selected Incidents With Potential," revised annually, is distributed independently through each agency. Check with your aviation safety manager for availability.

Safety Alert: Watch Out for Aircraft Turbulence!

Billy Bennett

Aircraft play a vital role in today's fire control operations, carrying out such crucial missions as water and fire retardant drops. Yet turbulence from aircraft can sometimes contribute to erratic fire behavior, potentially endangering firefighters. As the National Wildfire Coordinating Group notes in a training publication for firefighters, "The blasts of air from low flying helicopters and air tankers have been known to cause flare-ups" (NWCG 1992). Those on the fireline should keep this potential hazard in mind, mentally adding it to their list of 18 Watch Out Situations.

> Aircraft turbulence should be one of the unwritten Watch Out Situations for firefighters to keep in mind on the fireline.

A case in point occurred on July 11, 1996, on the Broad Canyon Fire in central Utah. At about 3 p.m., a wind shift caused the fire to jump containment lines during a burnout operation. A Cat D–7 dozer and dozer boss began constructing line around the slopover, which was burning in brush and 15-foot (4.6-m) juniper. A type 2 helicopter using a bucket with a 35-foot (10.7-m) line began making drops along the fire edge. When the helicopter approached the area near the dozer, the rotor downwash caused the fire to behave erratically, encircling the immediate area around the dozer and dozer boss with fire. The only escape was to push through the active fire into the safety zone of the black. As the dozer operator bladed through the fire, the dozer boss followed close behind, using the dozer as a heat shield. They managed to escape unharmed.

Several factors contributed to this near-tragic incident, including circumstances clearly identifiable as Watch Out Situations:

- Available fuels were very dry and extremely volatile.
- A sudden wind shift had already caused the fire to jump containment lines.

  Watch Out Situations:
  #15 Wind increases and/or changes direction.
  #16 Getting frequent spot fires across line.
- The incident occurred in a somewhat narrow part of the canyon, where topography might have influenced fire behavior.
- When the helicopter pilot approached the slopover, he could not make radio contact with firefighters on the ground. This caused a delay, because the pilot did not know specifically where to make the drop.

Resources assembling for the initial attack on the Broad Canyon Fire in central Utah, July 1996. Photo: Billy Bennett, South Carolina Forestry Commission, Spartanburg, SC, 1996.

Billy Bennett is a law enforcement officer and fire management officer for the South Carolina Forestry Commission, Piedmont Region, Spartanburg, SC. In July 1996, he was the Staging/Initial Attack Safety Officer for the USDA Forest Service and USDI Bureau of Land Management in central Utah.

Watch Out Situations:
#5 Uninformed on strategy, tactics, and hazards.
#6 Instructions and assignments not clear.
#7 No communication link with crew members/ supervisor.

- The airspeed of the helicopter as it approached the scene was about 46 miles per hour (74 km/hr), and altitude was less than 200 feet (61 m) above ground level. Firefighters on the ground believe that this was too low under the conditions, and the pilot now concurs.
- The helicopter was large enough to cause substantial rotor downwash (the larger the helicopter, the more rotor downwash to expect).

Fire behavior in brush-juniper fuels on the Broad Canyon Fire in central Utah, July 11, 1996. Fuels were extremely dry and volatile. Photo: Billy Bennett, South Carolina Forestry Commission, Spartanburg, SC, 1996.

If any of these contributing factors had been removed, the incident likely would not have occurred. However, rotor downwash was probably the final contributing factor to the erratic fire behavior and resulting entrapment. The firefighters were operating within acceptable risk limits before the helicopter arrived, having to some extent compromised only a minimum number of Watch Out Situations. Not until the helicopter arrived did acceptable risk escalate into unacceptable risk within just a matter of seconds.

One of the most important functions of fire managers on the fireline is to recognize when Watch Out Situations and Standard Fire Orders are excessively compromised, and to take immediate corrective action to ensure firefighter safety. Pilots will most likely not know how close firefighters on the ground are to this point of unacceptable risk. When air operations are in progress, pilots and firefighters alike must remember that no Watch Out Situation or Standard Fire Order specifically addresses how aircraft turbulence affects fire behavior. Pilots and firefighters should keep in mind that low or moderate hazards, under certain conditions, can quickly become high or extreme hazards due to unexpected aircraft turbulence.

This incident in no way suggests that turbulence from aircraft will always cause erratic fire behavior. However, it does suggest that aircraft turbulence should be one of the unwritten Watch Out Situations for firefighters to keep in mind on the fireline.

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Crew Resource Management Enhances Safety*

Patrick R. Veillette

> The offshore helicopter community has experienced a 54-percent decline in human error since adopting a strong Crew Resource Management program.

What would you do on your next flight on an airliner if you saw large flames coming out of the engine on the left (port) side of the aircraft and the airline captain announced that he had responded by shutting down the engine on the right (starboard) side of the aircraft? Would you inquire whether an error had been made?

This very thing happened on a British Midlands Boeing 737–400 airliner in January 1989. Due to incorrect cockpit information, the flight crew shut down the wrong engine after receiving an engine-fire warning along with smoke in the cockpit. When the captain announced to the passengers that he had shut down the starboard engine, everyone on the port side of the aircraft saw 10-foot (3-m) flames coming from the port engine. However, no one—not even the flight attendants—brought this to the attention of the flight crew. Because the crew had shut down the wrong engine, the aircraft was in a glide mode. The engine continued to burn and exploded before the aircraft could safely land, resulting in a crash landing with multiple fatalities.

Not only was an initial diagnostic error made, but even more importantly, those with access to critical information did not communicate it (Veillette 1995a). This accident, like many others, could have been prevented.

Training for Better Decisionmaking

Unfortunately, the wildland fire community is not the only one to suffer severely when human errors are made. Airliner crashes, like tragic incidents on wildfires, become headline news, particularly when there is catastrophic loss of life. The good news is that for the past two decades, the major airlines have painstakingly scrutinized their own operations in an effort to improve safety. It started in 1978, when a United Airlines DC–8 crashed due to fuel starvation while on approach to Portland, OR. This incident motivated United Airlines, eventually joined by other airlines, to invite leading

Smokejumpers boarding a plane. When the siren goes off, there is little time to sit and thoroughly plan crew coordination. Each person's role must be preplanned for smooth coordination within the crew. Photo: Pat Veillette, USDA Forest Service, Northern Region, Missoula, MT, 1997.

Dr. Patrick R. Veillette is a smokejumper captain on a Forest Service C–23A Sherpa for the USDA Forest Service, Northern Region, Missoula, MT.

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Cockpit view while approaching the site of a paracargo drop. Critical flight phases such as this require good crew coordination, proper planning, and timely communications. Photo: Pat Veillette, USDA Forest Service, Northern Region, Missoula, MT, 1997.

researchers from the National Aeronautics and Space Administration and other agencies and institutions to study their operations and recommend changes.

Thanks to this multiagency approach, significant modifications to training have prevented many human errors from causing catastrophes. These modifications are collectively known as Crew Resource Management (CRM), defined as "effective use of all available resources to achieve safe and efficient operations." The fundamental goal of CRM is better decisionmaking.

Comprehensive CRM programs consider the types of tasks and the environmental and organizational elements that tend to induce human errors, seeking to minimize the frequency and/or severity of such errors at the earliest possible stage. During the past two decades, comprehensive CRM programs have proven their worth in very risky aviation environments. In his 1991 study, Dr. Alan Diehl identified six major aviation organizations that have incorporated CRM, resulting in a drop in accident rates ranging from 28 percent to 81 percent (Diehl 1991). The offshore helicopter community, for example, experienced a 54-percent decline in human error after adopting a strong CRM program in 1988 (Albert 1989).

However, cursory CRM programs that were incorporated merely to satisfy Federal Aviation Administration requirements have failed. In fact, since introducing a variation of a CRM program, a major airline that had no prior CRM-related accidents has experienced three fatal accidents and two major incidents due to faulty CRM (Besco 1997). Clearly, there are differences between effective CRM programs (ones that are comprehensive) and those that do not work.

Comprehensive CRM Programs

An effective CRM program involves more than a 2-day course. Incorporating CRM means:

- Investigating how certain types of tasks and certain organizational and environmental factors induce human errors;
- Determining how information is transmitted so that it is readily understood (Veillette 1997a); and
- Exploring the stresses on and limitations of individuals and teams, how these affect overall performance, and how we should incorporate the knowledge gained into our decisionmaking.

Most traditional CRM courses concentrate on communications; situational awareness; decisionmaking; and attention, risk, stress, and attitude management.

- *Communications training* enhances our ability to disseminate critical information in a timely manner; and, more importantly, to bring about a change in the team's actions.
- *Situational awareness* makes crew members aware of the organizational and environmental elements surrounding them, how these elements will change over time, and how to stop error chains from developing.
- *Training in decisionmaking* develops skills in soliciting and scrutinizing information, formulating strategies for dealing with a task, choosing the optimal strategy with appropriate goals, and constantly reviewing progress toward implementing the decision to ensure that the strategy chosen is still the most appropriate.

- *Attention management* seeks to understand how to avoid distractions and to recognize the warning signs of error chains.
- *Risk management* emphasizes identifying risks in the operational environment, assessing the probability and severity of risks, deciding which risks deserve attention, and then applying proper intervention strategies.
- *Stress management* examines the obvious and insidious effects of physical, environmental, psychological, economic, and organizational stress; how these affect human performance; and how they can be managed.
- *Attitude management* focuses on recognizing when attitudes are hazardous and explores the role that hazardous attitudes have played in past accidents.

The latest CRM courses have encompassed some of the most recent research on decisionmaking in hazardous environments where task loads are high (Jensen 1995). These courses explore and discuss normal pitfalls in decisionmaking, using practical field and simulator exercises to incorporate and reinforce the lessons learned (Veillette 1995b; Veillette 1996a and 1996b; Veillette 1997b). Some of the latest courses incorporate decisionmaking pitfalls into realistic simulations and permit participants to make corresponding mistakes. Students learn to recognize early warning flags and to take appropriate preemptive measures in the future.

Applying CRM to Wildland Firefighting

Comprehensive CRM programs have greatly reduced the incidence of accidents caused by human error in high-risk operations other than wildland firefighting. Peer-reviewed journal research and substantive long-term statistics show that CRM has been scrutinized and thoroughly adopted in successful aviation organizations. But does the CRM training concept have potential applications for the wildland fire community, and how effective is CRM in a wildland firefighting environment?

In 1995, Dr. Ted Putnam (formerly with the USDA Forest Service's Missoula Technology and Development Center) held a wildland firefighters human factors workshop (Putnam 1995). He firmly recommended exploring and adopting CRM for wildland firefighting. In 1996, a modified form of CRM training was introduced to smokejumper spotters and helicopter managers. The response from the smokejumper base managers was extremely positive, and the concept has since been introduced in several I–378 air tactical group supervisor classes. CRM's introduction into the wildland fire community and its initial acceptance indicate its potential for improving communications, eliminating communication barriers, delegating tasks and assigning responsibilities, setting priorities, detecting failures, managing risks, and facilitating many other management processes central to wildland firefighting.

However, applying the airline CRM training programs directly to wildland fire management would be ineffective. Although many lessons have been learned when the CRM concept was taken from the airlines to other cultures and industries, simply presenting an airline's CRM course to the wildland fire community will not yield positive results. For one thing, a CRM course for wildland firefighters should use a mix of relevant accident types for review. Most importantly, CRM training needs to be modified to fit our environment and address our specific tasks in the wildland fire community.

CRM is a promising application based on a proven concept for reducing human-caused accidents and enhancing safety in high-risk environments. Appropriately adapted to meet the needs of the wildland fire community, it is well worth considering for adoption in wildland firefighting.

For more information on CRM, contact Dr. Patrick R. Veillette at the Missoula Aerial Fire Depot, Box 6, Airport Terminal, Missoula, MT 59801, tel. 406-329-4982.

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Debriefings: A Crew Resource Management Tool

During the evolution of Crew Resource Management training, numerous research efforts have measured crew performance and surveyed flight crews to determine the effectiveness of various methods. Much can be learned from these studies. Flight crews have noted that the consistent use of debriefings was an excellent long-term learning tool for all crew members. During research funded by the National Aeronautics and Space Administration at a major airline, the author used checklists during crew debriefs as an aid to stimulate feedback. Here is an extract from one of the checklists:

Crew Coordination/Communications:

- Did we address coordination under normal, abnormal, and emergency conditions?
- Was planning highlighted and were probable problems anticipated?
- Were open communications established?
- Was the timing of communications proper?
- Was critical information communicated in a timely manner?
- Were decisions communicated and acknowledged?
- Were duties assigned to ensure timely completion?
- Were communications relevant, complete, and verified?
- Were inquiry, advocacy, listening, conflict resolution, and critique practiced?
- Was active participation in decisionmaking encouraged?
- Did communications show concern for the accomplishment of tasks?
- Did communications show concern for the quality of team working relationships?

Real-Time High-Altitude Fire Mapping

Dana Cole, Jeffrey Myers, and Wayne Mitchell

Remote-sensing technology has been used in emergency management for nearly 50 years. One of the earliest uses was reported by Johnson and Thomas (1951), who employed a Polaroid Land camera to acquire photographic prints of a wildfire from an aircraft, then dropped the prints minutes later to fire camps. In subsequent years, the quality of imagery improved, as did access to multispectral data, while platforms higher in the atmosphere offered more global views.

After almost half a century, however, remote sensing continues to be used almost exclusively for planning, preparedness, and relief—in other words, before and after disasters occur. In recent years, remote-sensing technology has been used in conjunction with geographic information system (GIS) and global positioning system (GPS) technologies to map wildfires in and around Yellowstone National Park in 1988, assess property loss following the Oakland Hills Fire in 1991, monitor conditions around the Chernobyl nuclear reactor, and inventory pipeline failures during the 1993 Mississippi River floods. In all these cases, the operational utility of sensor data was limited by lack of real-time access to data by on-scene emergency managers.

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STARLink offers virtually instantaneous distribution of fire status data from remote-sensing platforms to field users with PC's.

Now, thanks to the Internet, a solution to this real-time data delivery dilemma could be at hand. During the 1996 fire season, the National Aeronautics and Space Administration's (NASA's) Satellite To Aircraft and Return Link (STARLink) technology was applied for the first time to wildfires in California. By refining the methods pioneered then, we might soon be able to provide emergency managers with access to vast amounts of near-real-time remote-sensing data—giving them, in essence, a current bird's eye view of an emergency or disaster as it unfolds. What follows is the story of how this recently declassified technology was first used for emergency management.

What is STARLink?

STARLink is a data relay system developed for the High Altitude Missions Branch at NASA's Ames Research Center in Moffett Field, CA. STARLink was installed in early 1996 on NASA's ER–2 aircraft, a domestic version of the military's U–2 aircraft. Imagery from scanner systems onboard the aircraft is transmitted on a real-time basis to a ground station via satellite and is then disseminated through the Internet.

The STARLink architecture has three major elements (fig. 1):

- An airborne element (using the ER–2 aircraft),
- A satellite element (the Tracking Data and Relay Satellite System (TDRSS)), and
- A ground station element at Ames Research Center.

The airborne element consists of a scanner system (the Thematic Mapper Simulator has proven most effective for fire mapping) together with a Ku-Band transmitter and a 30-inch (76-cm) steerable dish antenna mounted in a dome on top of the aircraft. The antenna system locks onto and tracks the NASA TDRSS-West satellite, continuously transmitting the scanner data to the ground receive station. Because of STARLink's high bandwidth capability (more than 200 megabits per second), data from several sensor systems can be transmitted simultaneously. The system also features a "return link" so that voice and data commands can be relayed back up to the aircraft.

After the link is established, the satellite relays the data down to a ground station network. The

Payload Operations Center at Ames Research Center then captures the digital imagery on an array of computer disks, where it is available for processing and redistribution within seconds of acquisition. Then the Internet World Wide Webpage interface allows users to download images from the disk array to their local systems for utilization. The entire relay process, from the moment the aircraft acquires the data to the moment imagery arrives on the field user's PC, typically takes about 5 minutes, depending on how many people have access to the Webpage and on the speed of their individual Internet connections.

STARLink's Debut: 1996 Wildfires

The 1996 wildfire season was the Nation's worst since 1952. More than 6 million acres (2.4 million ha) burned, including 666,000 acres (270,000 ha) in California. The situation in California was especially critical during the last half of August, when a series of lightning storms, preceded by a week of abnormally high temperatures statewide, ignited hundreds of fires between August 11 and August 26. Ninety-three fires escaped initial attack and consumed more than 366,000 acres (148,000 ha) within 3 weeks.

By mid-August, Federal and State agencies in California had exhausted their firefighter reserves, making it necessary to request firefighters from across the United States, supplemented by U.S. Army troops. Operations managers from the California Department of Forestry and Fire Protection (CDF) and other wildland firefighting agencies needed a current, accurate assessment of the situation in

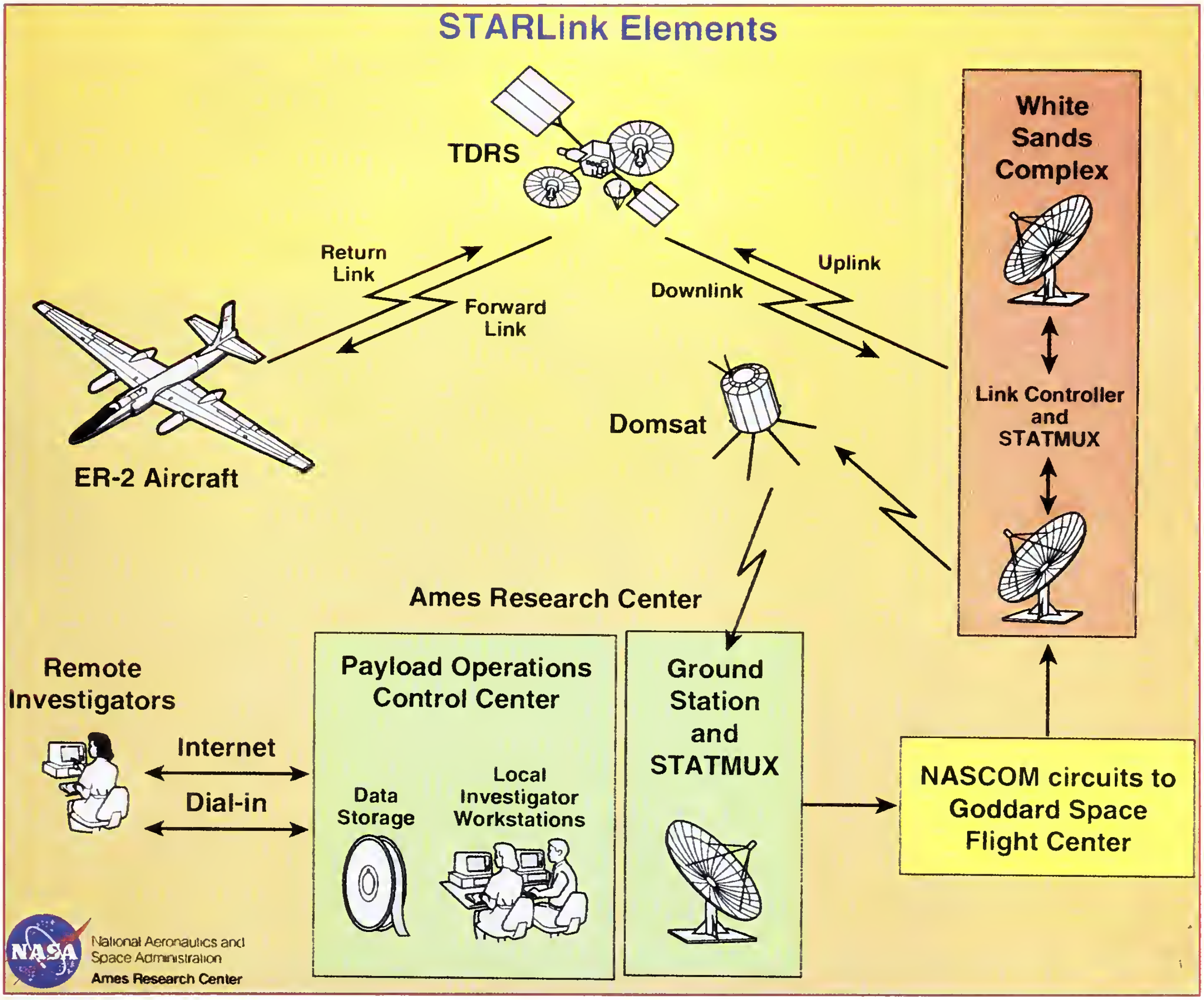

Figure 1—*Elements of NASA's Satellite To Aircraft and Return Link (STARLink) information system.*

order to set strategic priorities and to brief State and Federal officials. Traditional intelligence-gathering processes were not keeping up with the information demand. The need to fax maps also imposed an additional workload on already overburdened incident managers.

The CDF had previously worked with the High Altitude Missions Branch at NASA's Ames Research Center to produce wildfire imagery (Richardson 1993). When CDF fire managers called the Ames Research Center to request imagery for the 1996 fires, NASA's researchers described the new STARLink system, and a simple business process was created to take advantage of the technology. CDF's managers worked with field office and incident base staff to establish Internet connections, while NASA planned and then conducted the flight. The first flight produced usable imagery of the Fork Fire in Lake County, which ultimately burned more than 80,000 acres (32,000 ha) on the Mendocino National Forest and adjacent private lands. The planning section on the fire was able to access near-real-time imagery (fig. 2) at the same time as regional and statewide emergency coordination centers.

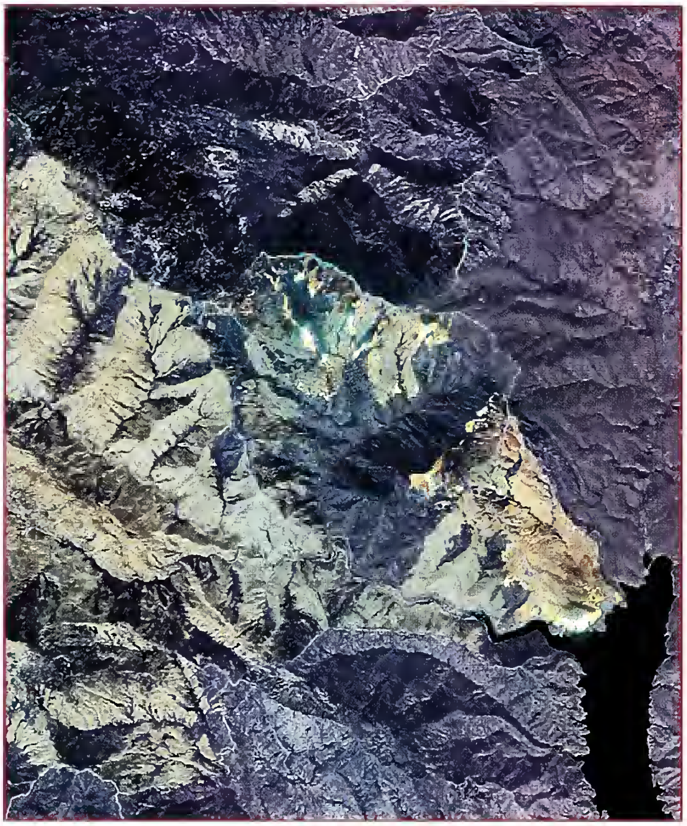

***Figure 2**—Imagery from the 1996 Fork Fire on the Mendocino National Forest in Lake County, CA. This imagery was delivered instantaneously via the Internet to the planning section for the incident.*

The Technology's Potential

It has been more than 30 years since researchers at the USDA Forest Service's Northern Fire Laboratory recommended using airborne thermal infrared line scanners for detecting and mapping fires under all atmospheric conditions. According to Hirsch (1963; 1964), the ideal fire monitoring remote-sensing system would allow detection of fire in its early stages, effective 24-hour operation, and the ability to distinguish between dangerous fires and those of little consequence. Hirsch believed that the most important capability of a remote-sensing system for fire mapping was to reproduce fireline size and location in relation to topography and vegetation.

In the past 30 years, major technological advances have been made toward achieving this capability. Even though the growing wildland–urban interface fire problem has magnified the complexity of fire mapping, advances in remote-sensing technology have made it possible to obtain extremely accurate fire perimeter information under any smoke or atmospheric conditions, as well as information on fire intensity, location of structures, and extent of damage (Cole et al. 1993). However, it has remained difficult to communicate this data in a timely manner to fire managers on the ground.

Before STARLink, NASA focused on—and succeeded in—downlink-ing spectral data via a 915-megahertz transmitter from aircraft to ground station receivers within a 300-mile (483-km) line-of-sight radius. For fires in California, this meant that data could be directly downlinked to NASA's Ames Research Center. However, the data then had to be processed, interpreted, and transported to fire managers. The total lag time between data acquisition and delivery to fire managers thus ranged from 8 hours (Richardson 1993) to 1–2 days (Ambrosia 1990). During the Yellowstone Fire of 1988, NASA transported its ground station receivers to the incident base at West Yellowstone, MT, which reduced the time needed for interpreters to provide mapped fire information to fire command

staff to about 4 hours after data acquisition (Ambrosia 1990).

But even a 4-hour delay severely limits the tactical value of remote-sensing data for emergency incident management. By adding a satellite uplink component and Internet connectivity, STARLink offers virtually instantaneous distribution of fire status data from remote-sensing platforms. Brass et al. (1996) have proposed research to develop technology for geo-correcting scanned data to a map base and integrating fire modeling and prediction capabilities. For line personnel equipped with laptop computers and GIS software, this could soon provide access to fire status maps within seconds of high-altitude scanner acquisition. Using built-in fire models and animation tools, line personnel will also be able to visualize fire movement in areas obscured by smoke or topography (fig. 3). Existing GPS technology will allow firefighting resources to be tracked and various tactical scenarios to be modeled and played out.

Although STARLink promises to become a powerful new tactical tool, its potential as a strategic tool might be even greater. On large conflagrations (such as the Yellowstone Fire of 1988) or when numerous major fires are burning over a large area (as in California during the August 1996 siege), STARLink can provide a rapid global overview of the situation. Regardless of their location, decisionmakers can view and download images from the Internet almost as quickly as they are acquired by scanners onboard the aircraft. Simultaneous access to the most current images will provide a common basis for making better informed and more timely decisions. This will greatly improve the potential for multiagency and interagency coordination in the following areas:

- Establishing priorities for response,
- Allocating critical firefighting resources,
- Developing strategies for handling multiagency response problems,
- Mobilizing disaster relief efforts more rapidly and efficiently,
- Sharing information, and
- Facilitating communications.

Limitations

Cost and Availability of Technology. Flight time for one of NASA's two ER–2 aircraft currently costs approximately $6,000 per hour. For a variety of reasons, these aircraft are often unavailable, especially on short notice. STARLink does not have a dedicated satellite, so uplink availability can

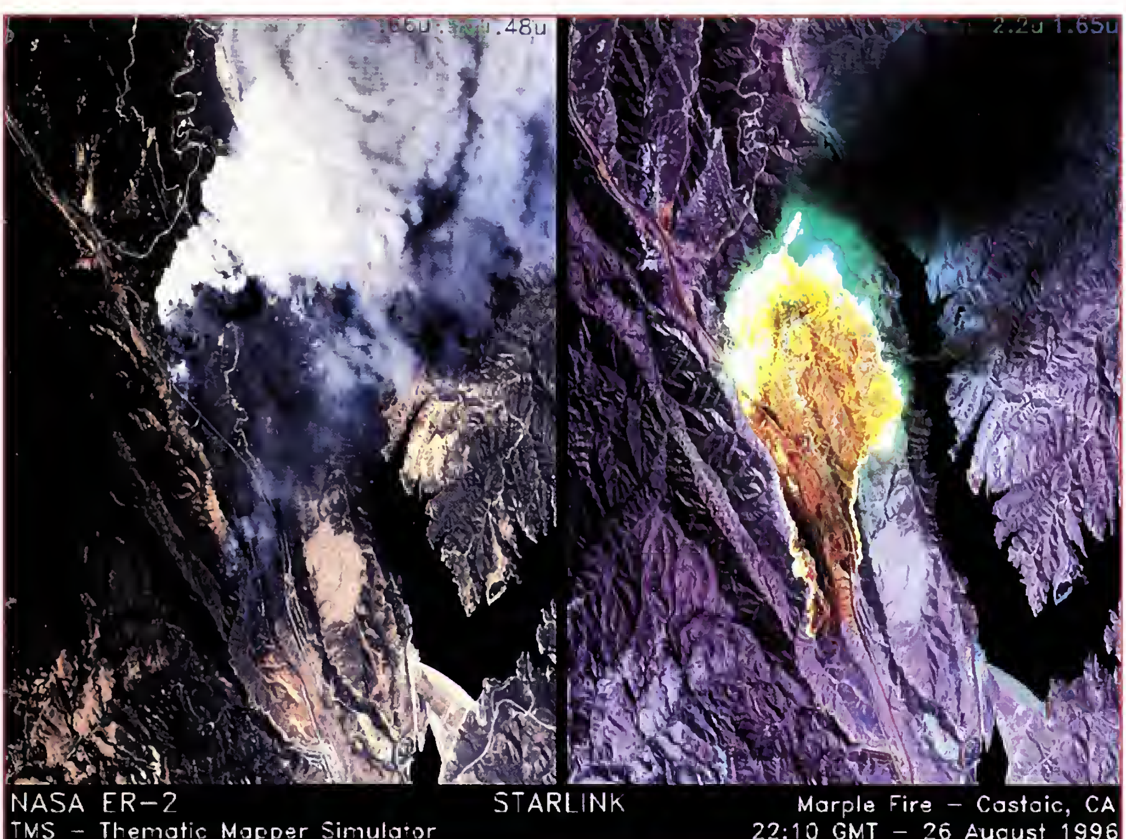

Figure 3*—Imagery in two bands (visible on left, near infrared on right) of a wildfire near Los Angeles, CA, on August 26, 1996. This imagery was delivered instantaneously via the Internet to fire planners before ground forces arrived on the scene.*

When fires are burning over a large area, STARLink can provide a rapid global overview of the situation, facilitating interagency response coordination.

also be limited. Even when aircraft and satellite uplink are available, end users on the ground must have access to the Internet to obtain real-time data. In many remote areas where wildland fires occur, this could require wireless modems or other technology not currently available to emergency service users on a routine basis.

Need for Geo-Correcting Data. Before aerial scanner imagery can be projected accurately onto a map base for incorporation into a GIS context, the data must be "corrected" to account for distortions caused by aircraft instability and instrument viewing geometry. NASA is currently working to adapt an in-flight Geo-Correction System (GCS) developed for military purposes. This GCS is built around a highly accurate fiber-optic gyro, a differentially corrected GPS receiver, and a pair of computers running custom-made GCS software. Until this GCS upgrade is complete, accurately mapped scanner data will continue to require postflight processing time (Brass et al. 1996).

Need for Specialized Skills. Interpretation of remotely sensed data, especially in the nonvisible spectral ranges, requires specialized knowledge that few emergency service users might possess, including those trained in conventional mapping techniques. The technological ability to obtain scanner data depicting a multitude of tonal values and spectral characteristics far exceeds current understanding of what the data actually depict on the ground. For example, imagery of active-burning conditions will require field survey and calibration to accurately interpret fire behavior implications. This training issue should be addressed in order to take full advantage of the technology.

Future Directions

Data delivery time has long been recognized as the single biggest limitation to the usefulness of remote sensing for emergency management (Jones and Marlatt 1980; Australian Emergency Management Institute 1996). The initial tests of NASA's STARLink technology during the 1996 fire season demonstrated that near-real-time scanner data covering very large areas can be made available to on-scene emergency managers, giving them a virtual multispectral bird's eye view of fires or other disasters as they unfold. With the anticipated addition of an in-flight data geo-correction capability, it will be possible to incorporate scanner data directly into existing GIS and GPS systems. The result will be a powerful new near-real-time mapping and management tool for users on the ground.

A major challenge will be to reduce the cost of data acquisition. This can best be accomplished by developing portable airborne scanner subsystems and telemetry systems using off-the-shelf components that are not sensor or aircraft specific. This will allow agencies to schedule and use their own aircraft for remote-sensing data acquisition.

For more information on STARLink and its fire-mapping potential, contact Dana Cole, California Department of Forestry and Fire Protection, 135 Ridgway, Santa Rosa, CA 95402, tel. 707-576-2913, fax 707-942-1380, e-mail: dana_cole@fire.ca.gov.

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Flying With the Media Over Wildfires

Michael G. Apicello

No matter how remote the location of a wildfire, there's a good chance the media will find it. Each year, the media seek out dozens of stories featuring the drama of wildland firefighting. Because some of the most spectacular firefighting activity occurs in the air, reporters often focus their stories on the aircraft and aerial resources used to fight fires.

In fact, media interest in wildland fire aviation has surged in the last few years. Today, almost half the media inquiries fielded at the National Interagency Fire Center in Boise, ID, are from producers worldwide who are intrigued by the use of aircraft and other aerial resources in wildland firefighting. From military C–130 Modular Airborne Fire Fighting Systems units to infrared platforms, rappellers, smokejumpers, and even cargo drops, just about everything we do in the air counts for the media as a good story.

> Although documentary film productions take time and require much oversight and energy, doing them right enables the parties involved to ensure safe operations.

Approaching Media Requests for Stories

Breaking news, feature articles, movies, and documentary films are but a few of the methods used by the media to tell stories. Each method has its own requirements, and agencies with fire management responsibilities must deal realistically with each. Based on the particular type of request, all parties involved in a media production must take a clear, systematic approach if agreements are to be reached that go beyond just covering the news to deepening the public's understanding of and appreciation for wildland fire management. Systematic planning and coordination are especially important for media productions on wildland fire aviation, where flying adds another dimension to the challenge of safely operating near wildfire.

Breaking News. Breaking news and related features are usually handled through the Incident Command System (ICS) protocol. ICS can deal with immediate requests and has procedures in place to assist media on large incidents. The chain of command for handling breaking news is well established and should be observed; normally, the incident commander has decisionmaking powers and will ask the information and air attack functions to coordinate an appropriate response to a media news request.

Documentary Films. Documentary films are much more difficult and require a different approach.

An aviation maintenance inspector checks a potential camera mount area on a P–2V aircraft. Before permitting any installation or aircraft modification, the Federal Aviation Administration requires aircraft to be inspected for safety. Photo: Courtesy of Discovery Communications, Inc., Bethesda, MD, ©1997.

Mike Apicello is the public affairs officer for the USDA Forest Service at the National Interagency Fire Center, Boise, ID.

These productions are more complex than breaking news stories. For their safe and accurate production, several key elements are needed:

- Comprehensive planning for air and ground safety,
- A cooperative spirit of commitment from all involved, and
- Finely tuned networks for coordinating all planning and operations.

If these elements are not in place or are dropped to meet a party's deadline, then the endeavor is probably not worth the risk. For example, to safely portray a successful wildland fire story, fires must be burning, personnel and resources must be available, and approved plans and communication linkages must be in place. If these conditions are not met due to poor networks for planning and coordination, then chances of success are slim.

To safely portray a successful wildland fire story, fires must be burning, personnel and resources must be available, and approved plans and communication linkages must be in place.

Before a filming flight, a Discovery cameraman checks the camera mounted on the tailboom of a Skycrane. Long before the camera was ever mounted, the film company began working with the Forest Service to plan the documentary. Photo: Courtesy of Discovery Communications, Inc., Bethesda, MD, ©1997.

Recent Experiences

Two recent examples illustrate what is needed to make a successful documentary film on wildland fire aviation. In early 1996, National Geographic television and the Discovery Communications, Inc., film division both began planning for documentaries that focused heavily on aerial firefighting resources. For both productions, filming started during the 1997 fire season, with completion scheduled for 1998.

National Geographic. National Geographic's "Firebombers" documentary portrays airtankers, lead planes, and the lives of the people who fly them. Filmed in its entirety on the Narrows Fire on California's Angeles National Forest in August 1997, the documentary involved 18 firefighting aircraft during 3 weeks of filming. National Geographic used a skilled three-person production crew, along with a designated agency liaison and a contract chase aircraft.

Prior to filming, the project was approved, appropriate certifications were issued, inspection criteria were met, and the foundation agreements were signed. Long before a single camera was mounted to a public aircraft or a chase plane left the ground, all air and ground safety operating plans were reviewed and shared with appropriate local fire and aviation management personnel. Before a single frame was shot, coordination channels were well established and the ground rules were set. During filming, coordination and communication occurred on a daily basis at local, regional, and national levels.

Thanks to all this painstaking planning and coordination, filming went off without a hitch. The result was a highly informative and entertaining television documentary that aired March 1, 1998. National Geographic has also offered to provide professional-quality film for pilot cockpit training and wildland fire management computer simulation training.

Discovery Communications. Discovery's documentary (under the working title "Wildfire") is a large-format film that captures the total essence of the wildland fire environment. This 3-year undertaking is expected to be released worldwide in early 1999.

Since large-format documentary films are projected on 70-foot by 70-foot (21-m by 21-m) screens, they often focus on scientific and educational topics of lasting interest and high visual appeal. For this documentary, Discovery signed an agreement to work with the five Federal agencies charged with wildland fire management responsibilities (the USDA Forest Service and the USDI Bureau of Indian

A production must have adequate planning time for safe and accurate completion. If you don't plan it, don't do it.

Affairs, Bureau of Land Management, National Park Service, and U.S. Fish and Wildlife Service) to produce educator and student packages that address modern wildland fire management and to make wildland fire information available through Discovery's highly popular and extensive information networks. Results of these collaborative efforts promise to entertain as well as educate global audiences for years to come.

Lessons Learned

Several major factors contributed to the success of the National Geographic and Discovery productions:

- Adequate lead time, from the point of initial contact to the desired filming date;
- Upfront agreement by the producers not to compromise key aviation safety standards (these standards include using the right tools, communicating for effectiveness, and keeping safety first and foremost in all planning and operations); and
- Strict adherence to all public laws, Federal Aviation Administration (FAA) requirements, and agency policies, procedures, and guidelines.

Early in the process, both productions involved yearlong negotiations that resulted in memorandums of understanding (MOU's) articulating how things would be done and how each party would benefit, and delineating policies, procedures, and safety requirements. The MOU negotiations facilitated coordination, planning, and implementation. Most importantly, however, they built familiarity and trust between the parties. The trust built during the entire process—from initial contact to "final wrap"—helped to ensure safety consciousness on the part of all involved throughout filming.

Ingredients for Success

Thanks to these experiences, there is now a systematic approach for dealing with these types of media requests in the future. Although documentary film productions take time and require much oversight and energy, doing them right enables the parties involved to ensure safe operations.

Adequate Planning Time. A production must have adequate planning time for safe and accurate completion. If you don't plan it, don't do it. Working on someone else's deadline can easily create unnecessary risk and should count as a "watchout situation." Adequate lead time constitutes at least a year of planning and working together before filming begins.

Open Communication. The production will succeed only with continuous, open, and honest communication that begins during the very first talks. It is vitally important for the parties to know each other's expectations and for agency personnel to understand how the producers will deal with hazards and mitigate risks. Before the parties reach agreement, they must elaborate their expectations and plans for risk management in discussions that involve aviation specialists (including contract specialists, pilots, mechanics, and inspectors)—the folks whose detailed knowledge and expertise are necessary to determine whether a project is a "go." During these preliminary talks, aviation program managers, air officers, and aviation personnel must make difficult decisions. Unless trust emerges and things feel right, it's time to step back.

In preparation for filming from a helicopter, a Discovery cameraman makes final camera adjustments after all inspections, modifications, and safety plans are in place. Photo: Courtesy of Discovery Communications, Inc., Bethesda, MD, ©1997.

Good Coordination. Coordination is another important ingredient for success. Coordination is good when the approval process moves smoothly from review, through inspections, to local planning, and finally to implementation on the ground and in the air. At each stage, clearances become green

lights, until final on-the-ground briefings lead to inflight operations and the camera starts to roll. Without coordination, those involved in incident management would not be able to perform the missions that the documentary is all about. Good coordination firmly links people, aircraft, airspace, lights, cameras, and action, enabling the documentary to capture our people doing what they professionally do best—working in the wildland fire environment.

Absolute Safety. The most important ingredient for success is safety. Unless a media production follows practices that are safe and prudent, it not only risks disastrous failure, but also puts the safety and efficacy of the firefighting operation itself at risk. All parties involved in a media production must adhere to basic aviation safety philosophy: they must use the right tools, be cost-effective with people and resources, and keep safety first and foremost.

Following these guidelines is a recipe for success. It's a lot of work but worth the effort. When done correctly, media productions accurately portray agencies and people, meet producers' goals, embrace the tenets of aviation safety, and ultimately help deepen the public's understanding of wildland fire aviation.

For more information on the National Geographic and Discovery documentaries and on working with the media, contact Mike Apicello, USDA Forest Service public affairs officer, National Interagency Fire Center, 3833 S. Development Avenue, Boise, ID 83705-5354, tel. 208-387-5460, fax 208-387-5386, IBM: mapicello/wo,nifc; Internet: mapicello/wo,nifc@fs.fed.us. ■

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    - Weather?
    - Confusion?
    - Turbulence?
    - Personnel?
    - Conflicting priorities?
5. Is there a better way to do it?
6. Are you driven by an overwhelming sense of urgency?
7. Can you justify your actions?
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